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Financial Analysis of Thai Banks: Effectiveness of Augmented Reality Visualization

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Abstract

The objective of the study is to examine the acceptance and usability of Augmented Reality (AR) visuals developed for industry analysis of Thai Banks and whether these visuals can outperform the table of numbers in representing financial accounting data. Convenient samples were used and the data were collected with self-assessed questionnaires from 109 users with minimum prior experiences with financial analyses.

The results from descriptive statistics indicates that despite having over 80% of respondents with little prior experience in analyzing financial performance of banking industry, the majority of them were able to correctly make prediction (96.4%), identify trend (82.6%) and compare banks' performance (70.6%). Their attitudes and perception towards Bank-AR visuals were above average. Although the overall usability score is average (53%), the respondents rated the Bank-AR visuals to be highly useful and had high intention to use them in the future.

Keywords : Banking Industry Analysis, Data Visualization, Augmented Reality, Learning Usability

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1. Introduction

One import part of an industry analysis is to analyze and compare financial performances of firms within their industry. This is because stakeholders of business tend to pay a great deal of attention to financial performance and ability to compete with firms in its own industry. Industry analysis is also an important element of a business plan so that management can form effective strategy to secure growth and success as well as correctly position the firm's products and services. With industry analysis, management can recognize opportunities and fend off threats. Stakeholders such as investors would be able to make better decision from their investment; lenders would be able to understand the liquidity position and solvency of the firm. Financial statements and financial ratios are typical sources of financial performance analyses.

A typical EXCEL spreadsheet with numbers and two-dimensional graphs are usually used to depict the comparative financial performances of firms in an industry. Nevertheless, the sheer numbers of matrices required to encompass the complexity of financial performance sometime make the depictions awkward. This is even more apparent in banking industry where its financial statements are unique and somewhat difficult to comprehend by inexperience users. Thus, the objective of this research is to develop simple and useful visuals that can engage and stimulate user's cognition through interactive visuals, the augmented reality visuals for banking industry or Bank-AR visuals in this case. It is hoped that users would be able to assess and understand financial data quicker as well as finding these innovative visuals useful in doing industry analysis.

It is indisputable that banking sector has an important role in economic development of any country, developing economies including. Commercial banks take many roles in developing country. For example, they help capital formation, provide loans to industry, and serve as facilitators in the movement of goods and services, financing trades, employment, consumer activities, and so on. In Thailand, commercial banks are highly regulated by the Bank of Thailand. If publicly listed, the Security Exchange Commission and the Stock Exchange of Thailand also dictate their compliances vigorously. Thus, naïve investors should learn and understand bank performance. Reading financial statements of banks can be quite challenging, the augmented reality visuals developed this research with actual banks data, called the **Bank-AR** hereafter, should be useful for minimal experienced people.

1.1 Financial Statement Analysis & Industry Analysis

To understand and evaluate a firm performance, analysts typically look at financial statements in order to see the financial position/condition and revenues/expenses of the company. Besides understanding a firm's condition, financial statement analysis includes the study of accounting ratios calculated from items in the statement of financial position and income statement. For example, asset utilization ratios, profitability ratios, leverage ratios, and liquidity ratios. Analysts would use the financial statements to determine the past, present, and future

performance of a company. By comparing the financial statements between firms in the same industry, one would be able to have a sense of a company's financial health. However, if companies have different accounting methods, it would be difficult to compare their performance using only the numbers from financial statements. The situation magnifies when benchmarking with industry average.

For commercial banks, with the scale 1-5, CAMELS rating is used to evaluate institution's financial performance [Saunders and Cornett, 2012]. CAMELS comprise a composite evaluation based on six components: Capital Adequacy, Asset Quality, Management, Earnings, Liquidity, and Sensitivity to Market Risk. The framework uses items from financial statements as well as market data for evaluation. Including financial ratios as part of performance analysis is quite common, especially in industry analysis of listed firms in capital markets all over the world. Besides, performance [Kumbirai and Webb, 2010], financial ratios are used for other purposes, for example, to predict bankruptcy [Altman, 1968], operation efficiency determination [Fethi and Pasiouras, 2010], and competitiveness measures [Halkos and Salamouris, 2014]. Thus, financial ratio depictions become the de facto standard in most corporates' annual reports that inevitably rely on the use of software tool like EXCEL.

1.2 Visual & Cognitive Learning with Augmented Reality

In an extensive review of literature behind visual analytics and computer and human perceptual and cognitive activities, Pohl et al. [2012] identified five relevant theories, namely, Sense making Theory, Gestalt, Theory, Distributed Cognition, Graph Comprehension Theory, and Skill-rule-knowledge model. The authors pointed out the advantages and disadvantages of each theory and recommended that future research agenda should come up with comprehensive theory that is not a merger of all existing theories into one unified theory. Researchers should carefully merge only related theories into a coherent framework, extend or transfer certain theories, or create an entirely new but novel theory. In the present study that investigates the usability of Bank-AR visuals in simple industry analysis task, Graph Comprehension Theory is most applicable. However, the interactive nature of augmented reality has lent itself partially to the thrust of Distributed Cognition Theory.

Originated by Pinker [1990], the Graph Comprehension's research has been flourishing. For example, Shah and Hoeffner reviewed graph comprehension literature from the standpoint of teaching graphical literacy to students [2002]. They identified factors that affect graph comprehension including visual characteristics of a graph, a viewer's knowledge about graphs, and a viewer's expectations about the content of the data in a graph. With respect to visual characteristics of a graph, Schonlau and Peters [2012] examined the effect of display formats (e.g., graph types, tables of numbers) on users' comprehension. They compared pie charts, bar charts, 2D/3D display chart formats, and 3-way table and found them to be sensitive to the nature of tasks such as estimating absolute size of proportion, differences, equality and sums, and iden-

tifying trends.

Following the Distributed Cognition framework, DCog for short, by Edwin Hutchins, Liu el al. elaborated how the theory is suitable for information visualization, especially in the area of visual analytics [Liu el al., 2008]. They pointed out the important of both internal and external representations that should be taken into consideration within a cognitive system of a person. Therefore, both individuals and the artifacts (representation media) being used, should be observed and propagated to fully understand how these two components interact with one another. Researchers then took on to separate directions, those focusing on visual exploration and analyzing the pattern of interactions [Jankun-Kelly, 2007; Pohl et al., 2012; Reda et al., 2014], analytic reasoning processes individual user characteristics [Brown et al., 2014; Green and Fisher, 2010; Ziemkiewicz et al., 2012].

Usability together with User Experiences is another strand of research that appears to be the hybrid of many theories, Graph Comprehension and DCog Theory including. The Nielsen Norman Group (https://www.nngroup.com/) extensively trains, consults, and studies user experiences on different artifacts. They research how users interact with website usability, iPad_App usability, and usability/user experiences on various components of E-commerce system (e.g., Homepage, Product-Pages, Shopping cart, customer services, transactional email, and so on). For any newly developed artifact, the study of its usability appears to be the first logical thing to do. Thus, the present research examines the usability of the Bank-AR visuals as a viable tool for industry analyses by inexperienced users. With the popularity of Pokemon Go, Augmented Reality (AR) technology has become visible to all walks of life. By integrating real image with virtual images, the technology allows a user to interact and experience real and virtual world simultaneously.

AR visualization enable users to rotate the images in 3D space. As compared to tables of numbers and graphs in EXCEL, previous studies on AR visuals found FinViz-AR visuals to be interesting, useful and acceptable. However, those AR visuals do not increase the learning performance nor do they reduce the cognitive load of the users. Users spent more time using AR visuals than 2D/3D graphs and tables. However, with easy to use AR visuals, novice users were able to assess financial performance of a firm similar to the experts. Nevertheless, experts spent more time analyzing the details when being presented with numbers in a spreadsheet table [18,19]. While FinViz-AR visuals represent the data from one firm at a time, the assessment task is likely to be less complicate than Bank-AR visuals. The design of Bank-AR visuals caters for industry analyses where the performance evaluation from several companies is visible together. Thus, the objective of the present study is to investigate whether novice users would be able to use the Bank-AR system for industry analysis and whether they find the visuals to be useful.

2. Research Method

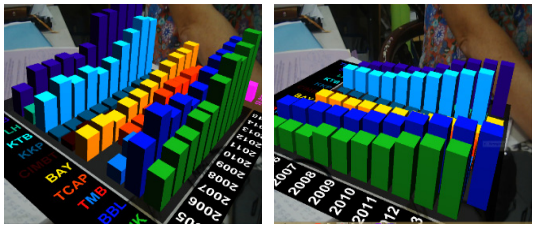
Data Collection The sampling frame of study

involves users with minimal or no experience. Thus, the second-year students from the Bachelor of Accountancy program in a large public university volunteered to take part in the study. They received class credit for participation. One hundred and nine usable questionnaires from 116 responses. <Table 1> shows the participant's self-assessed prior experiences. Note that the majority of respondents did not have many prior experiences with financial performance analyses (81.6%) nor did they have clear analysis framework (84.3%). 89.9% had not compared financial data between firms before.

〈Table 1〉 Participants' Self-Assessed Prior Experiences

Prior Experience (N = 109)	Mean (SD)	Num(%)× Exp < = 3
Expertise of financial Analysis	2.63(0.94)	90(81.6%)
Clear analysis framework	2.67(0.85)	93(84.3%)
Industry Analysis of financial data	2.14(1.04)	98(89.9%)
Familiarity of Thai banks	2.92(0.86)	86(78.9%)
Average prior experience score	2.58(0.73)	

*Likert Scale: 5 = a great deal; 4 = a lot; 3 = moderate; 2 = little; 1 = very little.



〈Figure 1〉 Bank-AR Visuals

Research Instrument Time-series data from 2005 to 2015 of eleven publicly listed Thai banks are used to construct augmented reality visuals for basic financial performance analysis of banking industry (see <Figure 1>).

The data includes four large-sized, three medium-, two small- and one very small banks. Selected data are included as the metrics or quantifiable measures of financial performance comparison among these banks (<Table 2>).

〈Table 2〉 Financial Measures/Metrics Used for Augmented Reality Visuals

Content	Abbreviation	Source
Loan and Investment Receivable	LOAN&INT RCV	BS
Total Assets	A	BS
Total Liabilities	L	BS
Total Equity	E	BS
Revenue	REV	PL
Net Revenue	NREV	PL
Depreciation and Amortization	DEP & AMT	PL
Income Tax Expense	TX	PL
Net Profit	NP	PL
Return on Asset	ROA	Ratio
Return on Equity	ROE	Ratio
Asset Turnover	ATO	Ratio
Net Fixed Asset Turnover	FATO	Ratio
Total Market Value	MV	MKT
Weighted Average Cost of Capital Economic Value Added	WACC EVA	MKT
Weighted Average Cost of Capital	WACC	MKT
Last Stock Price	P	MKT
Dividen Paid	DP	MKT
Current Market Capitalization	MC	MKT
Current Share Outstanding	SO	MKT
Free Cash Flow	FCF	CF
CF from Operating Activities	OPE	CF
CF from Invesetment Activities	IVF	CF
CF Flow from Financing Activities	FNF	CF

Source: BS = Balance Sheet; PL = Profit and Loss; Ratio = Financial Ratio; MKT = Capital Market Data; CF = Cash Flow.

Online questionnaire using Google form was used to assess the study constructs. The questionnaire comprises four parts as follows:

Prior experience with financial data analysis

of a bank: Self-assessment using 5 point Likert scale on four questions dealing with the subject's expertise in financial performance analysis, the extent of clarity of analysis framework being used, the experience of comparing financial data of firms in the same industry, and the familiarity with commercial bank business.

Financial performance analysis capability entails six questions that after looking at the Bank-AR visuals (see <Figure 1>), the participant would use the data to predict, to identify, to differentiate, to estimate, to calculate, and to explain the performance of a bank or banks in question.

Cognition and perception toward the use of Bank-AR visual contains five questions using 5-point Likert scale. After exposing to the Bank-AR visuals, the participants give their views on how they are able to see the data organization and meanings. The extent of how they would have analyzed data differently, made error in the analysis, and increase or decrease amount of time required for analysis.

Usability of the Bank-AR visuals is adapted from the SUS-System Usability Scale [Brooke, 1996]. Ten SUS questions were translated into Thai. Additional two questions are included to address participant overall view towards Bank-AR usefulness and behavior intention to use Bank-AR visual in the future. All questions use 5-point Likert scale.

3. Results

Descriptive statistics of 109 usable responses are shown in <Table 3>. Over 75% of respondents were able to analyze financial data using the Bank-AR visuals correctly. In terms of the ability to analyze financial data, the respondents perceived Bank-AR to give clearer structure of data (C1. Mean (SD) = 3.64 (0.85)), allow them to better understand the meanings of data (C2. Mean (SD) = 3.41 (0.84)), and enable them to use different methods of analysis (C3. Mean (SD) = 3.69 (0.72)). Nevertheless, they thought Bank-AR visuals might be somewhat prone to error (C4. Mean (SD) = 2.99 (1.01)) and required similar amount of time as with using EXCEL (c5. Mean (SD) = 3.05 (1.08)). Exploratory factor analysis (Varimax rotation) found two factors with the Eigen values of 1.734 and 1.451, accounting for cumulative sum of square 63.70%. With the loadings of 0.8 and above, the first factor, namely "data related' shows positive cognition and includes C1. Structure, C2. Meaning and the second factor, namely "effort-related" shows negative cognition and includes C3. Error-prone and C4. Time. Further analyses use the factor scores from these two factors.

In terms of usability of the Bank-AR visuals, the highest score after transformation using Brooke's formula is S5.Well integrated functions (Mean (SD) = 2.50 (0.70)) and S7.Learn to use quickly (Mean SD) = 2.48 (0.97)). Two lowest measures S10. Difficult to learn and S4.Need technical experts are low from their negative usability standpoints. Note that the scores are right in the middle resulting to the Mean (SD) of the overall SUS100 to be 53.0 from 100 point. However, Bank-AR was rated relatively high for industry analysis (Mean (SD) = 3.86 (0.83)) with high intention to use in the future (Mean (SD) = 3.53 (0.88)).

〈Table 3〉 Descriptive Statistics

Questions (N = 109)	Statistics Number (%)
Ability to analyze financial data using Bank-AR	
A1. Correctly predict	102(96.4%)
A2. Correctly compare	77(70.6%)
A3. Correctly seeing overall trend	90(82.6%)
Cognition/ Perception toward Bank-AR visuals	Mean(SD)
C1. Clear structure and organization of data	3.64(0.85)
C2. Understand meanings	3.41(0.84)
C3. Enable alternative data analysis method	3.69(0.72)
C4. Error Prone of data analysis	2.99(1.01)
C5. Time required as compared to EXCEL	3.05(1.08)
SUS-System (Bank-AR) Usability Scale*	Mean(SD)
S1. Would use frequently	2.21(0.95)
S2. Unnecessarily complex	2.17(0.92)
S3. Easy to use	2.35(0.96)
S4. Need technical experts	1.84(1.29)
S5. Well integrated functions	2.50(0.70)
S6. Inconsistency	1.89(0.95)
S7. Learn to use quickly	2.48(0.97)
S8. Cumbersome to use	1.86(1.01)
S9. Confident to use	2.13(0.87)
S10. Difficult to learn	1.82(1.18)
SUS100 overall score*, **	53.0(15.11)
Usefulness of Bank-AR for industry analysis	3.86(0.83)
Intention to use Bank-AR	3.53(0.88)

* Based on Brook (1996), the means score was calculated after reversal of negative measures and recoded them into the scale of 0~4 prior to multiplying the sum with 2.5 in order to get the calculating score of 100.
** minimum score = 17.5; maximum score = 82.50.

〈Table 4〉 Pearson Correlation Coefficients of Variables

	Intention	1st Factor	2nd Factor	SUS100	Usefulness	Avg Prior Exp
Intention	1					
1st Factor Data-related	.427***	1				
2nd Factor Effort-related	-.271**	.000	1			
SUS100	.629***	.597***	-.398***	1		
Usefulness	.538***	.291***	-.165*	.395***	1	
Average Prior Experience	.076	.249**	.212*	-.002	-.006	1

***p <= .001, **p <= .01, *p <=. 05.

The correlation matrix between variables (see <Table 4>). As expected, the control variable, Average Prior Experience has no correlation with intention to use nor the two usability measures. It does have some relationship with the two factor scores of cognition/perception measures. Likewise, the two usability-measures correlate highly with one another. Intention to use positively relates to all data-related cognition/ perception measure and negatively relates to effort-related factor. Intention to use also related to both usability measures, SUS100 and Usefulness (r = .629 and r = .538) at .000 level of significance.

〈Table 5〉 Simple Regression Models of the Intention to Use Bank-AR Visuals with Avg. Prior Exp as control variable

Independent variables	Std. Coef. Beta t-value (Sig.)	Std Coef. Beta of Avg. Prior Exp t-value (Sig.)	Durbin-Watson	Adjusted-R Square % (Std Err)	F-statistics (Sig)
1st Factor-Data related	.435 4.803(.000)	-.033 -.359(.720)	1.756	16.8% (.810)	11.907 (.000)
2nd Factor-Effort related	-.301 -3.180(.002)	.140 1.476(.143)	1.680	7.5% (.854)	5.391 (.006)
SUS100	.629 8.379(.000)	.077 1.022(.309)	1.745	39.1% (.693)	35.609 (.000)
Usefulness	.539 6.608(.000)	.079 .971(.334)	1.590	28.3% (.752)	22.266 (.000)

The correlations are high indicating possible multi-collinearity of variables. Although the multiple regression analysis (result not included here) between Intention to Use and all dependent variables shown in <Table 4> yield 48% of Adjusted R Square with F-statistics = 20.935 (p = .000), the Tolerance, Variance Inflation Factor (VIF) and Durbin-Watson statistics were marginal. Only two Beta coefficients are statistically significant, SUS100 (t = 4.381, p = .000) and Usefulness (t = 4.496, p = .000). <Table 5> shows simple regression models. The results confirm that each independent variable contributes to Intention to use Bank-AR. Except for the 2nd Factor-Effort related that has negative value, the more the respondents rated the data-related cognition/perception and the more usability and usefulness, the greater Intention to use Bank-AR. Control variable uses Average Prior Experience, which does not contribute to the variance explained in Intention to use Bank-AR visuals.

4. Discussion and Conclusion

Bank-AR visuals were used as alternative visualization for simple industry analysis which allow comparisons between companies' financial performance, especially those in the financial statements and publicly available in the website of the Stock Exchange of Thailand. Time series data were used in the development of Bank-AR visuals. The visuals were designed to be easy to use for novice users as in the case of the present study.

The results show that AR technology is still quite new for this group of respondents, despite their awareness of its existence through popular mobile games like Pokemon Go widely played by similar group of respondents. Nevertheless, the complexity and amalgamation of accounting and external market data affect the design of visuals to provide as less amount of inks a possible but still provide maximum data for analyses. Thus, no number is depicted on the consecutive bar graphs. In some cases, there is a guide bar to help the comparison (see <Figure 1>). This turns out to be the limitation as indicated by some respondents. Bank-AR users want to be able to see detailed graphs with numbers because they would feel more confident in the assessment of financial performance. Besides the need for num-

bers, the respondents would like to have EXCEL sheets as a backup. The familiarity and de facto visuals of spreadsheet used in business make it difficult for a novice user to embrace any other form of presentation wholeheartedly.

Similar to the results found in previous studies, respondents found Bank-AR visuals to be acceptable, useful, and they intend to use the visuals in the future Tanlamai et al. [2012]. There was no data collected from industry analysis experts in the present study. Thus, future research using Bank-AR should recruit experts to assess its practicality and applicability for analyzing industry financial performance data.

Besides user reports with questionnaire, future studies should consider additional usability evaluation methods are Cognitive walkthrough, Heuristic evaluation, usability testing through laboratory observation [Martinez and Bandyopadhyay, 2014]. Future research should also devise a more sophisticated set of tasks for research subjects to perform so that the Bank-AR can reach its potential as a practical, financial visual analytical tool to do industry analyses and even to as a teaching graphical literacy mechanism to students.

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